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To know what we cannot know: Global mapping of minimal detectable absolute trends in annual precipitation

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Fresh water resources, human societies, and ecosystems are expected to be strongly impacted by climate change, with precipitation trends being one of the most important elements that will be closely monitored. However, the natural variability of precipitation data can often mask existing trends such that the results appear as statistically insignificant. Information on the limitations of trend detection is important for risk assessment and for decision making related to adaption strategies under inherent uncertainties. This study reports on an effort to quantify and map minimal detectable absolute trends in annual precipitation data series on a global scale. Monte Carlo simulations were conducted to generate realizations of trended precipitation data for different precipitation means and coefficients of variance, and the Mann–Kendall method was applied for detecting the trend significance. Global Precipitation Climatology Centre (GPCC) VASClimO data was used to compute the mean and coefficient of variance of annual precipitation over land and to map minimal detectable absolute trends. It was found that relatively high magnitude trends (positive or negative) have a low chance of being detected as a result of high natural variance of the precipitation data. The largest undetectable trends were found for the tropics. Arid and semiarid regions also present high relative values in terms of percent change from the mean annual precipitation. Although the present analysis is based on several simplified assumptions, the goal was to point out an inherent problem of potentially undetectable high absolute trends that must be considered in analyzing precipitation data series and assessing risks in adaption strategies to climate change.